

PATENT COOPERATION TREATY
PCT
INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference IRN666171	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. PCT/AU02/00391	International Filing Date (day/month/year) 28 March 2002	Priority Date (day/month/year) 4 April 2001
International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁷ H02P 9/04, 9/14		
Applicant APPLIDYNE PTY LTD et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36. 2. This REPORT consists of a total of 4 sheets, including this cover sheet. ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT). These annexes consist of a total of 17 sheet(s).
3. This report contains indications relating to the following items: - I ☒ Basis of the report - II ☐ Priority - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability - IV ☐ Lack of unity of invention - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement - VI ☐ Certain documents cited - VII ☐ Certain defects in the international application - VIII ☐ Certain observations on the international application

Date of submission of the demand 24 October 2002	Date of completion of the report 1 August 2003
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/AU02/00391

I. Basis of the report

1. With regard to the elements of the international application:*

☐ the international application as originally filed.

☒ the description, pages 1, 2, 5, 6, 8-12, 14-20, 22-24, 26-34, as originally filed,
pages , filed with the demand,

☒ the claims, pages 36-38, 40, as originally filed,
pages , as amended (together with any statement) under Article 19,
pages 35, 39, 41-43, received on 5 June 2003, with the letter of 5 June 2003
pages 44, 45, received on 1 August 2003

☒ the drawings, pages 1/2, 2/2, as originally filed,
pages , filed with the demand,
pages , received on with the letter of

☐ the sequence listing part of the description:

pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages

☐ the claims, Nos.

☐ the drawings, sheets/fig.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU02/00391

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 3-11, 15, 16, 18-40	YES
	Claims 1, 2, 12-14, 17	NO
Inventive step (IS)	Claims 6-11, 16, 22, 23, 30-34	YES
	Claims 1-5, 12-15, 17-21, 24-29, 35-40	NO
Industrial applicability (IA)	Claims 1-40	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)

The following document identified in the International Search Report has been considered for the purposes of this report:

D1: WO 97/02454 A (RYHINER DANIEL). (See also English language equivalent: US 6274941)

This document discloses the process and device for regulation of the thermal output of combined heat and power generation systems. The regulation can be effected by changing the speed of rotation by discharging more or less electric power, preferably into the public supply network (load control of the generator) or by throttle (fuel control). The system described has a combustion engine and electric generator able to supply house connection and public supply network, rectifier, step-up transformer and inverter with combined current regulator, a temperature difference sensor, a control unit, a throttle and a tap for supply network monitoring and synchronisation.

NOVELTY AND INVENTIVE STEP - CLAIMS 1-5, 12-15, 17-21, 24-29, 35-40 (NO)

In light of this disclosure claims 1, 2, 12-14 and 17 lack novelty. Moreover, if small differences such as comparator means, which is not explicitly disclosed in D1 are regarded negligible in this instance, it is considered that it represents a conventional component, which is always expected to be present within or around the control unit of D1. Therefore these claims lack an inventive step.

Furthermore, independent claims 18, 20, 25, 35, 36 and 40 as well as appended claims 3-5, 15, 19, 21, 24, 26-29 and 37-39 relate to parameters or structures that are merely matters of design choice when the general technical knowledge about the state of the art is used and hence they cannot contribute to patentable invention. Therefore these claims, although novel, lack an inventive step.

Continued on the supplemental sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/AU02/00391

Supplemental B x

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of V**NOVELTY AND INVENTIVE STEP - CLAIMS 6-11, 16, 22, 23, 30-34 (YES)**

Claims 6-11, 16, 22, 23 and 30-34 meet the criteria set forth in PCT Article 33(2) for novelty. The prior art published before the priority date does not disclose the use of the dummy load in a control system for cogeneration unit consisting of a heat engine and an alternator having comparator sensing means, wherein the regulation is performed by controlling the parameters of the alternator and fuel supply of the heat engine.

Claims 6-11, 16, 22, 23 and 30-34 meet the criteria set out in PCT Article 33(3) with regard to the requirement of Inventive Step because the prior art does not obviously suggest to a person skilled in the art the use of the dummy load in a control system for cogeneration unit consisting of a heat engine and an alternator having comparator sensing means, wherein the regulation is performed by controlling the parameters of the alternator and fuel supply of the heat engine.

It is noted that the examiner disagrees with the argument presented in the applicant's reply of 05.06.2003, which states that D1 does not involve sensing and regulating AC electricity parameters and regulating such parameters by controlling characteristics of the alternator. Quite contrary the AC parameters are controlled and characteristics of the alternator are regulated, which can be seen from column 2 lines 25-33, column 3 lines 14-20 and Fig.1 of the US equivalent of D1. Both the control of electricity parameters and regulation of the characteristics of the alternator are done by current regulator (12). There is also a tap (ie. sensor) for supply network monitoring, which effectively monitors the AC electricity parameters.

- 3 -

unit to generate AC electricity for an electrical load, the AC electricity having parameters which have been established without the use of an inverter.

5 The present invention therefore provides a control system for a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the control system including:

- 10 a. parameter sensing means for sensing plural parameters, said plural parameters including designated parameters of the generated AC electricity, the parameter sensing means providing a sensed parameter value for each sensed parameter,
- 15 b. for each sensed parameter, a comparator means for comparing the sensed parameter value with a respective desired value, each comparator means being able to provide an error signal according to the difference between the sensed parameter value and the desired value;
and
- 20 c. one or more controlling means, the one or more controlling means being capable of using one or more of the error signals to provide a plurality of control signals, such that each control signal is able to regulate one or more of the sensed parameters;

25 wherein the regulation of the sensed parameters is performed by controlling characteristics of the alternator and a temperature of a body heated using energy from the cogeneration unit.

30 The present invention also provides a control system for a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the control system including:

- 30 a. parameter sensing means for sensing:
 - i. designated parameter(s) of the generated AC electricity;
and

- 4 -

- ii. the temperature of a body heated by energy provided by the cogeneration unit;
the parameter sensing means providing a sensed parameter value for each sensed parameter;
- 5 b. for each sensed parameter, a comparator means for comparing a sensed parameter value with a respective desired value, each comparator means being able to provide an error signal according to the difference between the sensed parameter value and the desired value; and
- 10 c. each comparator means being coupled to a respective controlling means, each controlling means being capable of using the error signal from the comparator means to provide a control signal, such that each control signal can be used to regulate a respective parameter;
- 15 wherein the regulation of the designated parameters is performed by controlling characteristics of the alternator, and the regulation of the temperature of the body is performed by controlling fuel supply to the heat engine.

20 The present invention is able to provide AC electricity to an electrical load either in conjunction with AC electricity obtained from an external power source (for example, a mains power distribution network) or independently of an external power source. Thus, the present invention is capable of at least two modes of operation, namely, a mains-connected mode or a stand-alone mode. In this form of the invention, the designated parameters are mode dependent.

25 More specifically, in the stand-alone mode the designated parameters are preferably the output voltage and frequency of the AC electricity generated by the alternator. In this mode, the present invention is able to regulate these parameters so as to compensate for variations in the magnitude of a component

30 of the electrical load, thus minimising large fluctuations in voltage and frequency which may otherwise result. In this respect, the component of the electrical load may be a household load.

29. SEP. 2003 16:56

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NO. 5000 P. 58/74

PCT/AU02/00391

Received 05 June 2003

- 4a -

In the mains-connected mode the designated parameter is preferably the power factor of the AC electricity generated by the alternator.

- b. comparing a sensed parameter value with a respective desired value, the comparison providing an error signal according to the difference between the sensed parameter value and the desired value; and
- 5 c. using each error signal to provide a respective control signal, such that each control signal can be used to regulate a respective parameter;
- wherein the regulation of the designated parameters is performed by controlling characteristics of the alternator, and the regulation of the temperature of the
- 10 body is performed by the controlling fuel supply to the heat engine.

It will also be recognized that the present invention also provides a method for controlling a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC

15 electricity for an electrical load, the control system including:

- a. sensing plural parameters, said plural parameters including designated parameters of the generated AC electricity, the sensing providing a sensed parameter value for each sensed parameter;
- b. comparing a sensed parameter value with a respective desired
- 20 value;
- c. providing an error signal according to the difference between the sensed parameter value and the desired value; and
- d. using one or more of the error signals to provide at least one control signal, such that each control signal is able to regulate one
- 25 or more of the sensed parameters;

wherein the regulation of the sensed parameters is performed by controlling characteristics of the alternator and a temperature of a body heated using energy from the cogeneration unit.

- 30 It will also be recognized that the present invention also provides a method for controlling a cogeneration unit, the cogeneration unit including a heat engine

- 7a -

and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the method including:

- a. sensing parameters, the parameters including:
 - i. designated parameter(s) of the generated AC electricity; and

The decrease in the effective magnitude of the resistive load may inhibit the ability of the control system to respond to 'switch on' transients which may be caused by fluctuations in the household load. That is, where once the effective magnitude of the resistive load may have been sufficient to be used as a 'buffer' to accommodate fluctuations in the household load, in the situation just described the resistive load may not be large enough to enable it to be used to compensate for such fluctuations.

Advantageously, the present invention overcomes the above-mentioned problem by providing a mode (herein referred to as the 'electrical priority mode') which provides the control system with the ability to maintain supply of AC electricity suitable for the household load in circumstances where the temperature of the body would otherwise result in the AC electricity being unsuitable (for example, the frequency being too low).

In electrical priority mode, the fuel supply to the heat engine may be fixed to a predetermined supply rate (for example, a maximum supply rate), or may be varied so as to maintain a fixed buffer over the household load.

Electrical priority mode may be selected/deselected by a user using a switch, or perhaps by way of a menu selection on a user interface. The selection/deselection may be communicated to the controller.

In an alternative form of the invention, a "smart" controller may be used. In this form, the smart controller may be able to switch the control system to electrical priority mode based on a prediction that the household load is about to increase. Such a prediction may be based on previous usage patterns, or user selections or other data that may be available to the smart controller.

In a form of the invention which includes a smart controller, the smart controller may also be able to select electrical priority mode when the household requirement approaches the alternator output (that is, when the dummy load heat

dissipation has reduced below a predetermined level), then automatically disconnect the electrical priority mode when the buffer has again increased to an appropriate level.

- 5 A system of the present invention which is able to support an electrical priority mode may further include the following means:
- 10 A. means for disabling temperature/fuel control until a threshold temperature is reached (that is, replace the desired temperature value with a threshold temperature value);
- 15 B. same as (A), but also including means for adding an additional heat load either internal to the house or external (wasting it) or both, to delay the time before the threshold temperature is reached, or avoid reaching it; or
- C. adding a large enough additional internal and/or external heat loads to ensure that maximum heat can always be dissipated at the desired temperature, and maintain control to desired temperature.
- 20 In relation to (A) and (B), in these cases the stand-alone electrical priority mode is only operable until the body reaches the threshold temperature, at which

Starting the Cogeneration Unit

At initial start up, switches 61, 63, and 64 are positioned in the stand-alone position and switch 62 is switched to an open position. As is evident from inspection of figure 1, in this configuration the mains power supply from the mains power distribution network is isolated from the co-generation unit and the alternator 100 output is isolated from the household load 70. Furthermore, the frequency controller 90 preferably initially sets the effective magnitude of the dummy load 122 to a minimum value.

10

At start up, the fuel regulator is 'opened' to provide gas to the burner 11, and the burner 11 is lit to begin operation of the heat engine 10.

Soon after the burner 11 is lit, the heat engine 10 starts to generate steam. At this stage, a battery 45 is used to rotate a starter motor (in this case, DC motor 30) for a short period of time to start rotation of the heat engine 10. In the preferred embodiment, the operation of the DC motor 30 is controlled by start-up controller 40 which is connected to battery 45 which in turn is connected to battery charger 46. Battery charger 46 is connected directly to power circuit 60.

20

Once the rotation of the heat engine 10 has been initiated by the DC motor 30, the heat engine 10 then starts to operate using mechanical power generated by the heat engine 10 itself. At this point, the start-up controller disengages the DC motor 30 from the heat engine 10.

25

During startup, the frequency and voltage of the electricity generated by the alternator 100 are sensed by parameter sensing means 80.

Here then, the desired frequency value (f_{des}) and the sensed frequency value (f_{act}) are input to comparator 81, while the desired voltage V_{des} and the sensed voltage V_{act} are input to comparator 82.

30

In this case, a critically damped response is desirable. Such a response provides a faster response, but at the expense of larger overshoots.

5 The voltage control signal is provided to the field current controller 130 which controls the current in field winding 102 of the alternator (or the equivalent on permanent magnet hybrid alternators) so as to achieve the desired value. As will be appreciated increasing, or decreasing, the current in the field winding correspondingly varies the magnetic flux in the alternator, which in turn correspondingly varies the induced Emf and thus the output voltage.

10 Although reference has been made to the use of a DC motor 30 to start the heat engine 10, it is to be understood that the present invention need not be so limited. Indeed, in an alternative embodiment of the invention, the alternator 100 is able to operate as a motor, thus obviating the need for a separate starter
15 motor. In this form of the invention, AC current used to rotate the alternator (which in this case is acting as a motor) may be provided by the mains power distribution network (if available) or from a battery via an inverter.

20 In yet another embodiment of the present invention, the alternator 100 may include a separate additional winding which enables it to function as a DC motor. In this form, the alternator 100 may include suitable mechanical or electronic commutation to provide a steady direction of torque.

25 Turning now to figure 2, from startup mode 200, once the alternator is providing AC electricity having the desired frequency and voltage, the control system transitions to a 'stand-alone electrical priority mode' 202.

Stand-alone Electrical Priority Mode

30 Referring again to figure 1, the control system may be configured for stand-alone electrical priority mode by closing switch 62 so as to provide the alternator

29. SEP. 2003 16:53

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NO. 5000 P. 65.74
PC 00000000/00391
Received 05 June 2003

- 25a -

electricity to the household load 70 in addition to the dummy load 122, or
alternatively, the output

Claims

1. A control system for a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the control system including:
- 5
- a. parameter sensing means for sensing:
- i. designated parameter(s) of the generated AC electricity; and
- 10 ii. the temperature of a body heated by energy provided by the cogeneration unit;
- the parameter sensing means providing a sensed parameter value for each sensed parameter;
- b. for each sensed parameter, a comparator means for comparing a sensed parameter value with a respective desired value, each comparator means being able to provide an error signal according to the difference between the sensed parameter value and the desired value; and
- 15
- c. each comparator means being coupled to a respective controlling means, each controlling means being capable of using the error signal from the comparator means to provide a control signal, such that each control signal can be used to regulate a respective parameter;
- 20
- wherein the regulation of the designated parameters is performed by controlling characteristics of the alternator, and the regulation of the temperature of the body is performed by controlling fuel supply to the heat engine.
- 25
2. A control system for a cogeneration unit according to claim 1 wherein the electrical load includes a household load, the household load being connected to both the alternator and an external AC power source.
- 30

- c. using the error signal from the comparator means to provide a control signal, such that each control signal can be used to regulate a respective parameter;

wherein the regulation of the designated parameters is performed by controlling characteristics of the alternator, and the regulation of the temperature of the body is performed by controlling fuel supply to the heat engine.

18. A programmed computer for controlling a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the programmed computer including software and hardware for:

- a. sensing parameters, the parameters including:

- i. designated parameter(s) of the generated AC electricity;
and

- ii. the temperature of a body heated by energy provided by the cogeneration unit;

such that the sensing provides a sensed parameter value for each sensed parameter;

- b. comparing a sensed parameter value with a respective desired value, the comparison providing an error signal according to the difference between the sensed parameter value and the desired value; and

- c. using each error signal to provide a respective control signal, such that each control signal can be used to regulate a respective parameter;

wherein the regulation of the designated parameters is performed by controlling characteristics of the alternator, and the regulation of the temperature of the body is performed by controlling fuel supply to the heat engine.

21. A multi-mode control system for a cogeneration unit according to claim 20 wherein in the first mode the cogeneration unit operates independently of an external AC power source, and in the second mode the cogeneration unit operates in conjunction with an external AC power source.
22. A multi-mode control system for a cogeneration unit according to claim 21 wherein in the first mode the electrical load includes a dummy load and a household load.
23. A multi-mode control system for a cogeneration unit according to claim 22 wherein the effective magnitude of the dummy load is controlled by the controlling means associated with controller used to regulate the frequency parameter such that the control of the dummy load is able to be used to regulate the frequency of the AC electricity.
24. A multi-mode control system for a cogeneration unit according to claim 21 wherein in the second mode the electrical load includes a household load.
25. A control system for a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the control system including:
- parameter sensing means for sensing plural parameters, said plural parameters including designated parameters of the generated AC electricity, the parameter sensing means providing a sensed parameter value for each sensed parameter;
 - for each sensed parameter, a comparator means for comparing the sensed parameter value with a respective desired value, each comparator means being able to provide an error signal according

to the difference between the sensed parameter value and the desired value; and

- 5 c. one or more controlling means, the one or more controlling means being capable of using one or more of the error signals to provide a plurality of control signals, such that each control signal is able to regulate one or more of the sensed parameters;

wherein the regulation of the sensed parameters is performed by controlling characteristics of the alternator and a temperature of a body heated using energy from the cogeneration unit.

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26. A control system for a cogeneration unit according to claim 25 wherein the control system is operable in at least a first and a second mode.

15

27. A control system according to claim 26 wherein in the first mode the cogeneration unit operates independently of an external AC power source.

20

28. A control system according to claim 27 wherein the sensed parameters include the temperature of the body.

25

29. A control system according to claim 27 or 28 wherein the designated parameters of the generated AC electricity include:

- a. frequency of the generated AC electricity; and
b. voltage of the generated AC electricity.

30

30. A control system according to claim 27 wherein the electrical load includes a dummy load and a household load.

31. A control system according to claim 30 wherein the effective magnitude of the dummy load is controlled by a control signal.

32. A control system according to claim 26 wherein in the second mode the cogeneration unit operates in conjunction with an external AC power course.
- 5 33. A control system according to claim 32 wherein the sensed parameters include the temperature of the body.
34. A control system according to claim 32 or 33 wherein the designated parameters of the generated AC electricity includes the power factor of
10 the generated AC electricity.
35. A method for controlling a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the control
15 system including:
- a. sensing plural parameters, said plural parameters including designated parameters of the generated AC electricity, the sensing providing a sensed parameter value for each sensed parameter;
 - 20 b. comparing a sensed parameter value with a respective desired value;
 - c. providing an error signal according to the difference between the sensed parameter value and the desired value; and
 - 25 d. using one or more of the error signals to provide at least one control signal, such that each control signal is able to regulate one or more of the sensed parameters;
- wherein the regulation of the sensed parameters uses the control signals to control characteristics of the alternator and a temperature of a body heated using energy from the cogeneration unit.
- 30

- 44 -

36. A control system for a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the control system including:
- 5 a. parameter sensing means for sensing:
- i. at least one designated parameter of the generated AC electricity; and
- ii. the temperature of a body heated by energy provided by the cogeneration unit;
- 10 the parameter sensing means providing a sensed parameter value for each sensed parameter;
- b. for each sensed parameter, a comparator for comparing a sensed parameter value with a respective desired value and providing an error signal according to the difference between the sensed
- 15 parameter value and the desired value; and
- c. each comparator being coupled to a controller for using a respective error signal to provide a control signal for regulating a respective sensed parameter, such that at least one of the designated parameter control signals is provided to the alternator;
- 20 wherein the regulation of said at least one designated parameter is performed by controlling characteristics of the alternator and regulation of the temperature of the body is performed by controlling fuel supply to the heat engine.
- 25 37. A control system according to claim 1 wherein the control signal provided to the alternator includes an alternator field winding current control signal.
- 30 38. A control system according to claim 2 wherein the designated parameter regulated by the alternator field winding current control signal includes the voltage of the generated AC electricity.

- 45 -

39. A control system according to claim 2 wherein the designated parameter regulated by the field winding current control signal includes the power factor of the generated AC electricity.

5 40. A method for controlling a cogeneration unit, the cogeneration unit including a heat engine and an alternator driven by the heat engine, the alternator generating AC electricity for an electrical load, the method including:

10 a. sensing parameters, the sensed parameters including at least one designated parameter of the generated AC electricity and the temperature of a body heated by energy provided by the cogeneration unit such that the sensing provides a sensed parameter value for each sensed parameter;

15 b. comparing each sensed parameter value with a respective desired value;

c. providing an error signal for each sensed parameter according to the difference between the sensed parameter value and the desired value; and

20 d. using a respective error signal to provide a control signal for regulating a respective sensed parameter, such that at least one of the designated parameter control signals is provided to the alternator;

25 wherein the regulation of said at least one designated parameter is performed by controlling characteristics of the alternator and regulation of the temperature of the body is performed by controlling fuel supply to the heat engine.